(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 May 2005 (12.05.2005)

PCT

(10) International Publication Number
WO 2005/042837 A1

(51) International Patent Classification[7]: D21G 1/00

(21) International Application Number:
PCT/FI2004/050155

(22) International Filing Date:
1 November 2004 (01.11.2004)

(25) Filing Language: Finnish

(26) Publication Language: English

(30) Priority Data:
20031588 3 November 2003 (03.11.2003) FI

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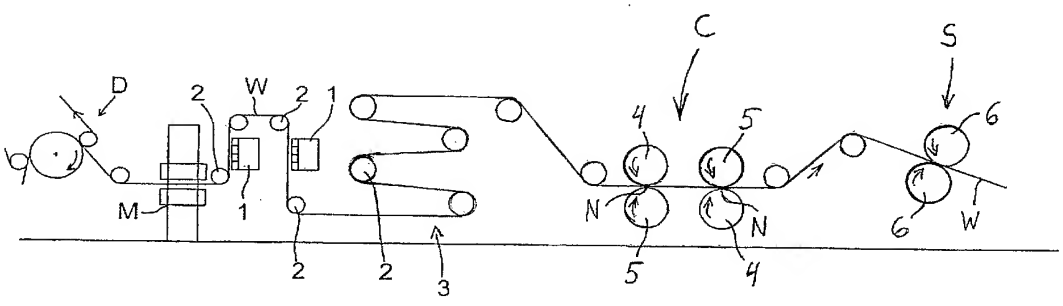
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A PRECALENDERING METHOD AND A TREATMENT LINE FOR PAPER



(57) Abstract: In a precalendering method the paper web is moistened and guided through a precalendering nip (N) that is formed between two surfaces. In the nip heat is conducted on the surface of the paper web (W) to be precalendered, and pressure is exerted thereon, whereafter the web is coated. The delay between the moistening and precalendering of the same side of the web (W) is 0.6 to 6.0 s. Thus, because of the long dwell time thereby attained it is possible to reduce the porosity and roughness of the surface of the base paper by means of precalendering before coating in a film transfer coater (S) taking place in the same line.

WO 2005/042837 A1

A precalendering method and a treatment line for paper

The invention relates to a precalendering method in which a paper web is moistened and guided through a precalendering nip formed between two surfaces, wherein in the nip heat is conducted on the surface of the web to be calendered and pressure is exerted thereon, whereafter the web is coated. The invention also relates to a treatment line for paper comprising devices located successively in the travel direction of the paper web for performing the aforementioned actions.

After the paper has been dried, desired surface structure of the web is attained by means of a mechanical treatment conducted for the surface, i.e. calendering. There are many calendering methods, but it is characteristic to all of them that the web is brought through one or more nips, which is/are formed between two surfaces, typically between rotating roll surfaces. The purpose of calendering is to improve the paper quality by pressing the paper into a particular standard final thickness and especially by smoothening its surface. When the calendering is followed by coating of the paper, the process in question is precalendering, in which the surface of the paper is treated in the calender in such a manner that it obtains suitable properties in view of the coating process in particular. In this respect, the purpose of precalendering is for instance to bind loose particles on the surface and close the surface so that the coating layer would become even.

In the precalendering process it is possible to influence the web by temperature and pressure. Typically heat is transferred on the surface of the web in contact with a hot contact surface guiding the web through the nip, for example via the hard metal surface of a calender roll. By using a soft coating at least on the surface of the second roll or by passing an elastic band via this second roll or a special shoe element, it is possible to form a longer nip, a so-called extended nip in the travel direction of the web by means of elements pressed against each other on both sides of the nip with a fixed force, in which nip the nip pressure produced by the mutual loading of the elements (pair of calender rolls or a calender roll and a shoe) is distributed on a longer area in the travel direction of the web. If two-sided treatment is desired for the pa-

per, the web is guided through two successive nips, in which the rolls are in reverse order. The moisture content of the web also affects the calendering result, and thus it is significant to which moisture content the web is dried or remoistened before precalendering.

After the precalendering the paper is subjected to coating, wherein coating mix is spread on the surface of the calendered paper by means of a suitable method. The coating mix is an aqueous mixture, which contains pigment that affects the optical properties of paper, as well as binding agent for attaching the pigment. By means of precalendering methods the aim is to attain a suitable surface for the paper for coating, primarily to make the surface smoother and especially to produce a dense surface for the base paper. In present coating methods it is possible to spread small amounts of coating agent quite evenly as well.

In the process of coating precalendered paper, it has been observed that problems are caused by the roughness and absorption capacity of paper. The water used in the coating relaxes the changes produced in the paper in the precalendering process. The original shape of the fibers is restored and the fibers compressed in the calendering become "tubular" again. As a result of this the surface of paper tends to become rougher again in connection with coating. The same problem occurs in all finishing treatments of surface succeeding the precalendering, in which the surface of paper enters in contact with water, as for example in surface sizing.

The roughening problem has also occurred in base papers containing mostly mechanical pulp by means of which it is not possible to attain good coverage in the coating process with small amounts of coating agent. Other paper grades may also face similar problems. On the other hand, the aim is to keep the coating amounts within fixed target values defined for example by the paper grade.

International publication WO 01/98585 discloses a precalendering method in which the web is guided to the calendering nip in suitably high inlet moisture, and said web is passed through this calendering nip in a relatively low calendering pressure by utilizing the sufficiently long

dwell time with the hot surface of the nip attained by means of the long calendering nip as well as the sufficiently high temperature on this surface, wherein it is possible to increase the surface temperature of the web above the T_g-point of the glass transition temperature of the fibers. The deformation can be attained in the fibres of the surface layer of paper, the roughening caused by the relaxation of the same having been the cause of problems, and the fibers in the middle in the z-direction may be left unaffected, wherein the bulkiness of paper is maintained. Typical characteristics of the method include high inlet moisture of precalendering, between 10 and 20 %, and additional drying to the target moisture after precalendering, wherein the aim is to intentionally increase the roughness and return the fibers partly to their original shape. Thus, the surface does not become any rougher when it is exposed to the effect of water in the next coating process. Alternatively, it is possible to select the precalendering parameters in such a manner that paper attains the target moisture already in the precalendering process before coating.

Publication WO 02/103109 discloses a precalendering method in which a paper web is guided via moistening devices to a precalendering nip after drying. It has been mentioned that suitable dwell time between the moistening devices and the precalendering nip is 0.05 to 0.5 s. By means of a suitably selected effective time of the moistening water it is possible to moisten both surfaces of the web, leaving the central part substantially unmoistened. After the precalendering process the web is guided through a coating station.

Despite of the development of precalendering methods it has not been possible to reduce the roughness and absorption capacity on such a low level which would be desirable in view of the coating process.

The purpose of the invention is to eliminate the aforementioned drawbacks and to improve the surface quality in precalendering with respect to the aforementioned variables, wherein an ideal quality is attained for paper for example in view of film transfer coating. Thus, it is possible to select for example the amounts of coating agent without limitations set by the quality of the surface to be coated.

To attain this purpose, the method according to the invention is primarily characterized in what will be presented in the characterizing part of the appended claim 1.

It is possible to facilitate the precalendering process by providing a long dwell time between the moistening and precalendering. The delay between the moistening and precalendering, when examining the travel of the moistened side of the web to the point where it enters in contact with the hot nip surface is 0.6 to 6.0 s, advantageously 0.8 to 1.5 s. Due to the long absorption time of water the porosity and roughness of the surface of the base paper is reduced and the coating layer becomes more even and smoother.

It is possible to conduct the precalendering for example by means of a soft calender, a shoe calender, a belt calender with a resilient surface or a metal belt calender, which all comprise a heated surface that is in contact with the paper web for the duration of time determined by the length of the nip and the web speed and with a pressure determined by the nip load. By means of the hot surface it is possible to attain a specific surface temperature in the web. The heated surface is in the nip in contact with at least that surface of the nip that is coated after the precalendering. If both surfaces of the web are coated, two successive nips are used in which the location of the calendering elements is symmetrical to the plane of the web, or it is possible to use one nip in which there are heated elements on both sides of the nip.

When the web moistened within a sufficiently long effective time is brought in contact with the hot surface in the calendering nip under pressure, it is possible to considerably reduce the absorption capacity and roughness of the surface of the paper. Because high web speeds require a long distance between the moistening point and the calendering nip to attain the aforementioned dwell times, it is possible to arrange the web to travel along a winding path from the moistening point to the first or only precalendering nip. Thus, it is not necessary to increase the machine length. By arranging one or several elements, such as rolls guiding the travel of the web within this distance so that it can

be transferred, it is possible to adjust the distance as well as the dwell time.

It has to be noted that the surface temperature of the hot roll must be above the glass transition temperature so that the surface fibers can be brought to the glass transition temperature. The surface temperature of the surface which is in contact with the web in the calender nip with a sufficiently long dwell time is between 100°C and 300°C, advantageously between 150°C and 250°C, wherein a sufficient effect is attained even at high machine speeds (with shorter dwell times). The temperature can be for example between 250 and 300°C. For practical reasons it is not reasonable to keep the surface temperature in a temperature of over 300°C, but in principle, it is possible to use temperatures of over 300°C in the invention. If two successive calender nips are used for the treatment of different sides, the second one advantageously has a higher temperature than the first one, because the lower moisture content in the second nip requires a higher temperature in order to reach the same deformation. On the other hand, the base paper often has asymmetric properties (roughness, absorption) when it enters the precalendering process, wherein it may be necessary to perfom the calendering in an "asymmetrical" manner to a suitable degree to balance the aforementioned differences.

By means of a long nip it is possible to produce small pressure and a long dwell time, by means of which, it is on one hand possible to save bulk and on the other hand to raise the temperature of the fibers on a high level. The inlet moisture of calendering and the calendering temperature constitute variables by means of which the calendering result relating to the surface quality can be adjusted either by means of one variable or both variables so that it becomes suitable in view of coating. It is, for example, possible to keep one of the variables constant and change the other to obtain a desired smoothness and density on the surface. High moisture level is advantageous also in that respect that after calendering the final moisture is not too low although high temperature is used.

The treatment line according to the invention, in turn, is characterized in what will be presented in the characterizing part of the appended claim 7. The travel path of the paper web before the coating unit between the moistening device and the hot precalendering nip surface is arranged to be sufficiently long so that the aforementioned effects advantageous in view of coating can be implemented.

In the following, the invention will be described in more detail with reference to the appended drawings, in which

Fig. 1 illustrates the effect of moistening amount on the PPS-s10 roughness with different dwell times in precalendering performed by means of a soft calender,

Fig. 2 illustrates the effect of moistening amount on the Cobb-Unger oil absorption with different dwell times in precalendering performed by means of a soft calender,

Fig. 3 illustrates the effect of the dwell time on the PPS-s10 roughness at different moistening in precalendering performed by means of a soft calender,

Fig. 4 illustrates the effect of the dwell time on the Cobb-Unger oil absorption at different moistening amounts in precalendering performed by means of a soft calender, and

Fig. 5 shows a papermaking line in which precalendering according to the invention is utilized.

Fig. 5 shows an apparatus placed in a continuous papermaking line in which a paper web is first produced from fiber suspension in a former part and then dried by pressing and heating. From the drying section D of the paper machine in which the drying has taken place by means of heat, the continuous paper web W travelling at the web speed required by the production speed of paper is guided to a calender C under the guidance of rolls 2, in which calender the precalendering is performed. From the calender the paper web is guided continuously at the same

web speed to a coating unit S. Thereafter the coated paper web is guided via drying to the reeling up process in which successive reels are formed thereof in a continuous reeling up process (not shown).

The apparatus comprises a moistening device 1 that is located between the drying section D and the calender C in the travel direction of the web. The moistening device 1 is arranged to moisten the surface of the web in a manner known as such by means of steam or a water jet of small droplet size. The moistening device is advantageously a water moistener that makes it possible to portion an accurate amount of water on the surface of the web. The moistening device 1 is arranged to moisten that side of the web that will be positioned against the hot nip surface (hot precalendering element, such as a thermoroll or a hot metal-coated belt) in the precalendering nip. The moistening device 1 is arranged sufficiently far away from the precalendering nip N of the calender in the travel direction of the web so that there is enough time for water to be absorbed on the surface of the web W that will be positioned against the hot nip surface in the precalendering nip N.

In the drying section D, the paper has been dried down to the total moisture of 1 to 10 w-%, advantageously 2 to 6 w-% to attain an even moisture profile. Thus, the amount of water portioned on the dried web by means of the moistening device 1 is such that water is absorbed in the paper approximately 0.2 to 15 g/m^2 /side, advantageously 0.5 to 3/g/m^2/side. Fig. 5 shows two moistening devices 1, one on each side of the web W, to perform two-sided moistening, wherein the aforementioned dosage quantities are advantageously used on both sides. Fig. 5 also shows a measurement device M located between the drying section D and the moistening device 1 to measure to properties of the paper web, for example the moisture profile and/or general moisture level, wherein the results can be taken into account in the moistening process following thereafter. There may also be other measurement devices at suitable locations.

To accomplish a sufficiently large distance between the moistening device 1 and the precalendering nip N, and to adjust the dwell time irrespective of the web speed, an adjustment device 3 is used. In the

adjustment device 3 the web is passed back and forth along a winding path under the guidance of guiding elements 2, in this case rolls, on which path the travel direction of the web is reversed at the location of the guiding element 2. In the figure the web makes four successive turns, but there can also be a different number of turns. The turn does not necessarily have to be 180 degrees or more, but it can be smaller than that, for example between 130 to 180 degrees. The curves can also have another orientation than horizontal, they can be for example vertical. At least one, preferably several guiding elements 2 that produce the directional change can be transferred substantially in the direction of the free run of the web to extend or shorten the curve i.e. the distance produced by the guiding element.

By means of the adjustment device 3, such a distance from the moistening point (moistening device 1) to the precalendering nip N is attained that the delay between the moistening and precalendering is 0.6 to 6.0 s, advantageously 0.8 to 1.5 s.

Fig. 5 shows a calender C that performs the precalendering, in which a web moistened on both sides by means of moistening devices 1 is precalendered by performing the same treatment on both sides. In the first precalendering nip N, the web W is calendered between a hard thermoroll 5 and a soft-faced roll 4. The second precalendering nip N accommodates the hard thermoroll 5 now on that side of the web which contained the soft-faced roll 4, i.e. the order of the elements is changed. The dwell time is advantageously the time used by certain surface element of the web to travel from the moistening point (dosage point of water) into contact with the hot surface of the precalendering nip.

After the calender C the web W is guided to a coating process that is performed in the coating unit S in which an aqueous coating agent composition, a coating mix, is spread on at least that surface of the web that has been in contact against the hot nip surface in the precalendering and in which a suitable quality has thus been attained in the surface of the web. The coating mix is spread on the surface of paper by means of a suitable method. The coating mix is an aqueous mixture, which contains pigment that affects the optical properties of paper, as

well as binding agent for attaching the pigment, and possibly other auxiliary agents.

In the figure the coating is performed as a two-sided film transfer coating in a film transfer coater that comprises two rotating rolls 6, between which the precalendered paper web W travels. A thin layer of coating agent is spread on the surface of both rolls 6 and it is transferred on the surface or the web in the nip between the rolls 6. Other coating methods are also possible.

When the moistening water has been allowed to absorb in the web for a sufficiently long time before precalendering, the absorption capability and roughness of the surface can be reduced in the precalendering before coating, and the coating layer becomes more even and smoother. This is advantageous especially in small coating amounts, for example in the manufacture of LWC paper.

The moistening, precalendering and coating are conducted as an on-line process in the papermaking line, wherein the calender is positioned in the so-called dry end of the machine producing paper from pulp, after the drying section. The moistening device or moistening devices 1 are positioned after the drying section, wherein the moistening is performed on the paper web that has been dried down to certain final moisture in the drying section. However, it is possible that the part of moistening of paper is started already inside the drying section, on the web that has dried in the drying process, but has not yet reached the final moisture, before the moistening devices 1 following the drying section. The moistening inside the drying section can also entirely replace the moistening after the drying section. It possible to use the aforementioned amounts of water per side in this case as well. In this case the aim is that despite of the final drying after the moistening the moisture content of the web before the calender is higher than before the moistening.

The moistening devices 1 can be VIB moisteners well known in the field, by means of which it is possible to accurately adjust the dosing of the amount of water on the surface of the paper web W.

The invention is especially well suited for precalendering of base papers containing mechanical pulp, for example for precalendering of LWC base papers which are coated by means of film transfer coating (sizer coater). The invention is not restricted solely to this paper grade, but it can also be utilized for precalendering of other coated wood-containing and woodfree paper and paperboard grades. Although the advantages of the invention are obvious especially when relatively light coated paper grades (LWC, ULWC) are produced, the invention is not restricted to the amount of coating, and it can also be used in paper grades with a thicker coating. Examples of other coated paper grades include MWC, FCO, WFC, and paperboard grades FBB and SBS.

In the following, the invention will also be described by means of examples which do not restrict the invention.

Precalendering tests were performed for LWC base paper with a grammage of 40g/m^2 by means of one-nip OptiSoft soft calender comprising a hard roll and a soft-faced polymer roll as rolls forming a substantially short nip. The inlet moisture before moistening was 2.2 % (total moisture), linear pressure in the precalendering nip 148 kN/m and the temperature of the thermoroll 200 °C. The web speed was 1,000 m/min. The PPS roughness of the base paper was 5.5/6 μm (TS/WS) before the treatment. The PPS roughnesses were measured from the bottom side (WS, the side against the wire) with different dwell times and amounts of moistening water. Similarly, the Cobb-Unger oil absorptions were measured from the same paper, whose initial values were 19/15 g/m^2(TS/WS). The results are presented in Figures 1 to 4.

The results show that with dwell times of 600 ms or more it is possible to reduce the roughness (PPS s-10) and absorption capacity (Cobb-Unger) even more, and especially the dosed amounts of moistening water 1 to 3 g/m^2 /side have an advantageous effect. The tests illustrate the treatment performed on one side, but the same results can be expected in a two-sided treatment of the web. The figures show the amount of water supplied through the nozzles. The amount of water passed to the paper is typically smaller than the (dosed) amount of

water coming from the nozzles. The amount of water shown in the figures, 1 to 4 g/m^2, corresponds to the water amount of approximately 0.5 to 2g/m^2 passed (absorbed) to the paper.

5

Claims:

1. A precalendering method in which a paper web is moistened and guided through a precalendering nip (N) formed between two surfaces, wherein in the nip heat is conducted on the surface of the paper web (W) to be calendered and pressure is exerted thereon, whereafter the web is coated, **characterized** in that the delay between moistening and precalendering of the same side of the web is 0.6 to 6.0 s.

2. The method according to claim 1, **characterized** in that the delay is 0.8 to 1.5 s.

3. The method according to claim 1 or 2, **characterized** in that in the moistening the amount of water dosed in the paper web is 0.2 to 15/m^2 /side, advantageously 0.5 to 3/g/m^2/side of absorbed water.

4. The method according to any of the preceding claims, **characterized** in that the paper web (W) is guided from moistening to precalendering along a winding path, the length of which can be adjusted to adjust the delay.

5. The method according to any of the preceding claims, **characterized** in that after the precalendering the paper web (W) is coated in the same treatment line by guiding it after calendering at the same web speed in the form of a continuous web to coating.

6. The method according to any of the preceding claims, **characterized** in that the paper web (W) is LWC base paper.

7. A treatment line for paper in which on the travel path of a paper web (W) that is arranged to convey forward the paper web moving at web speed, there is a moistening device (1), a calender (C) for precalendering the surface of the paper web and a coating unit (S) for coating the paper web precalendered in the calender, **characterized** in that the travel path of the paper web between the moistening device (1) and the calender (C) is arranged to have such a length with respect to the web speed that the delay time of the web between the moistening device (1)

and a hot precalendering nip surface of the calender (C) located on the same side with respect to said moistening device is 0.6 to 6.0 s, advantageously 0.8 to 1.5 s.

8. The treatment line according to claim 7, **characterized** in that on the travel path of the paper web, between the moistening device/devices (1) and the calender (C), there are several guiding elements (2) of the web which are arranged to guide the web along a winding travel path, and the position of at least one, advantageously several guide elements (2) can be changed in such a manner that the length of the path travelled by the web between the moistening device/devices (1) and the calender (C) changes.

9. The treatment line according to claim 7 or 8, **characterized** in that the calender (C) comprises two precalendering nips (N) at the location of which the surface of the heated calendering element, such as the surface of a roll (1), is positioned on different sides of the web, and in the travel direction of the web, after the precalendering nips (N), there are one or more coating units (S) which contain means for conducting coating on both sides.

10. The treatment line according to any of the preceding claims 7 to 9, **characterized** in that the calender (C) is a soft calender, a shoe calender, a belt calender with a resilient surface or a metal belt calender.

11. The treatment line according to any of the claims 7 to 10, **characterized** in that the coating unit (S) is a film transfer coater.

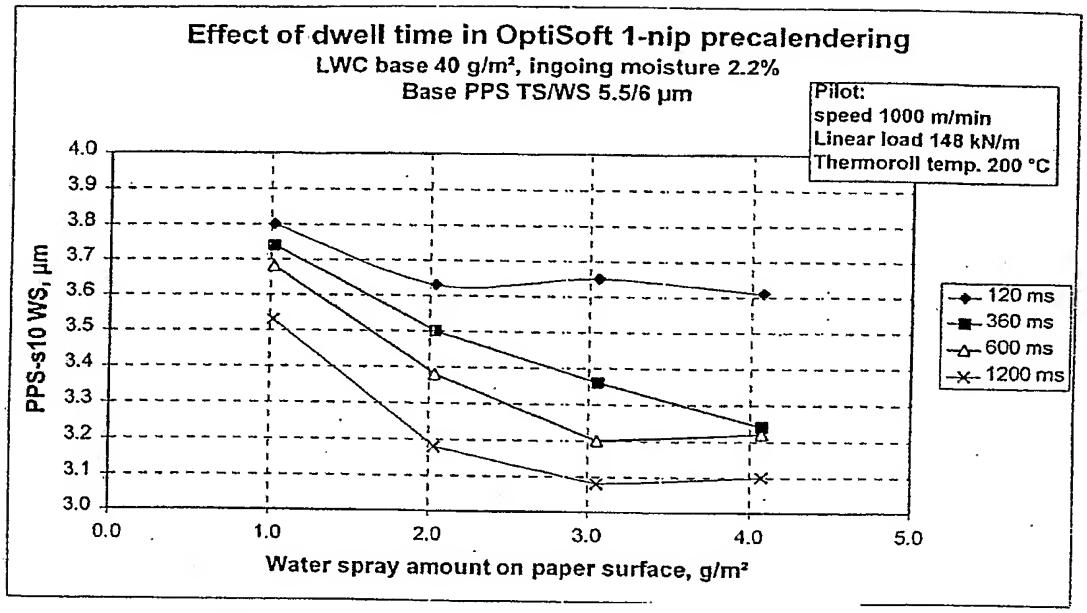


Fig. 1 Effect of moistening amount on the PPS-s10 roughness

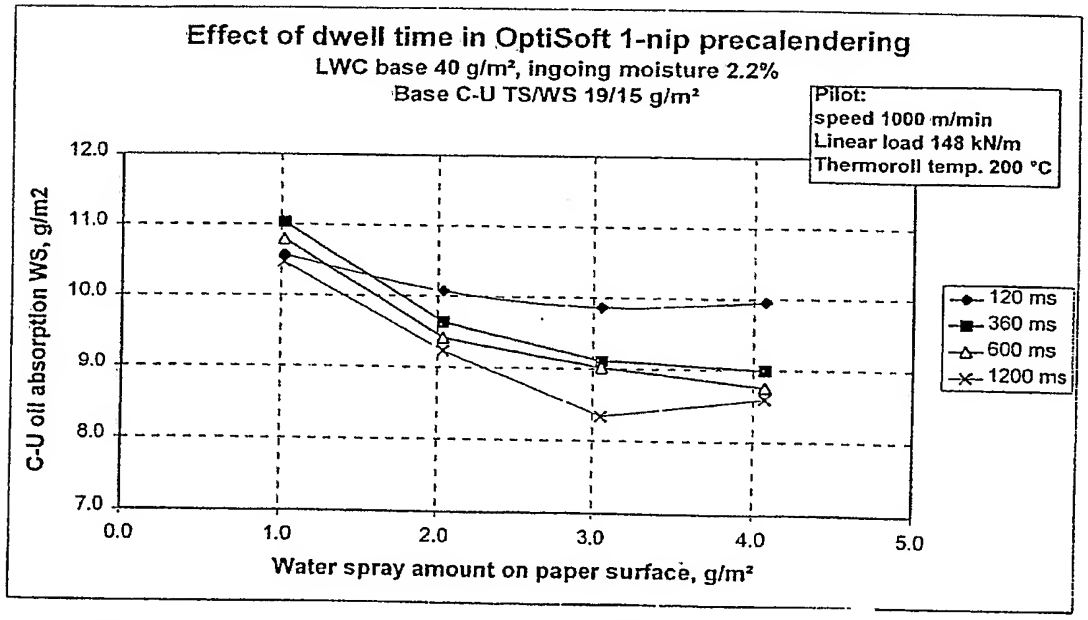


Fig. 2 Effect of moistening amount on the Cobb-Unger oil absorption

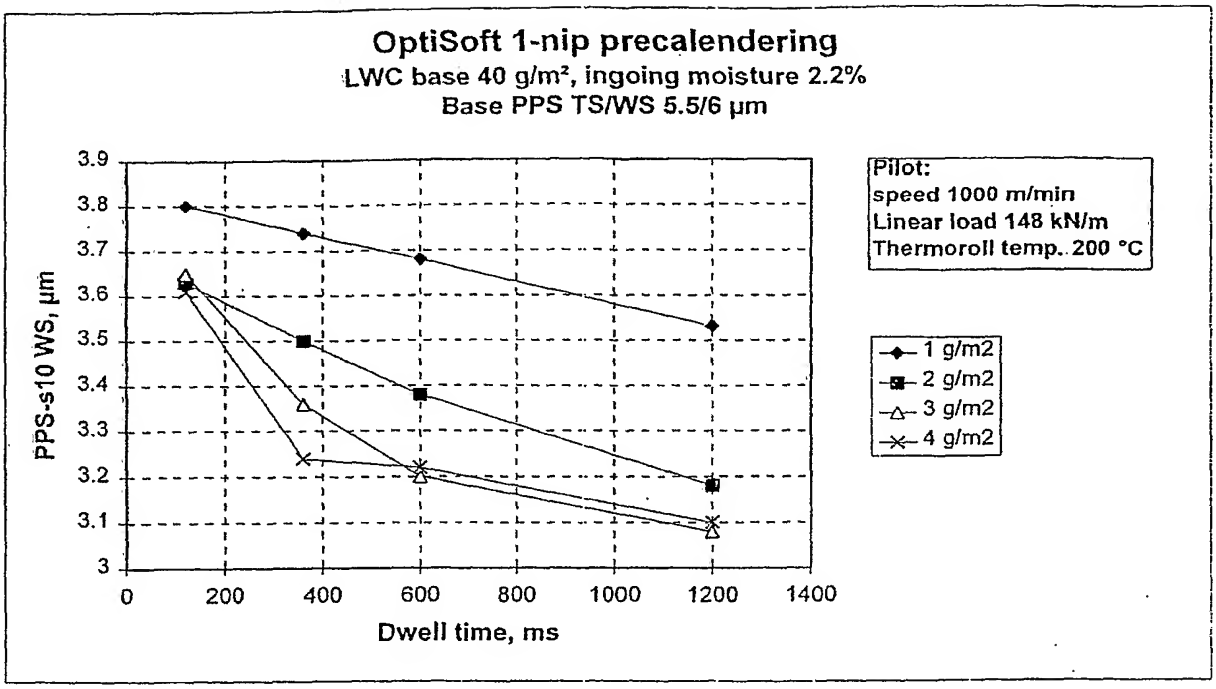


Fig. 3 Effect of dwell time on the PPS-s10 roughness

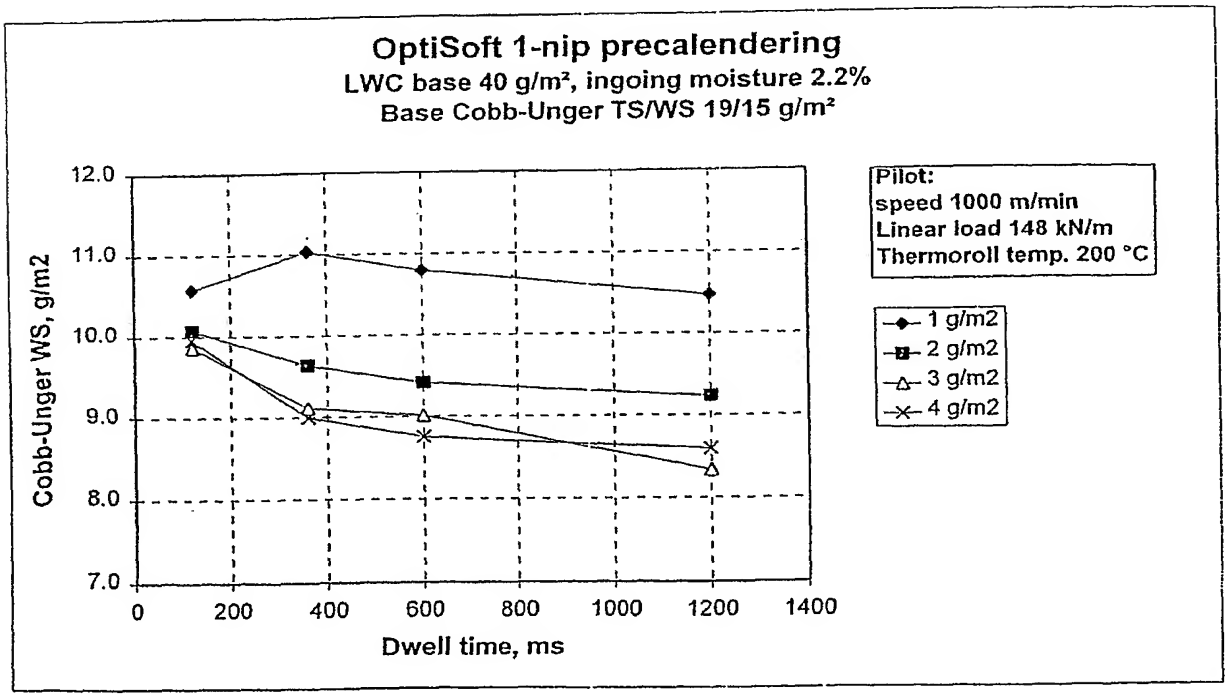


Fig. 4 Effect of dwell time on the Cobb-Unger oil absorption

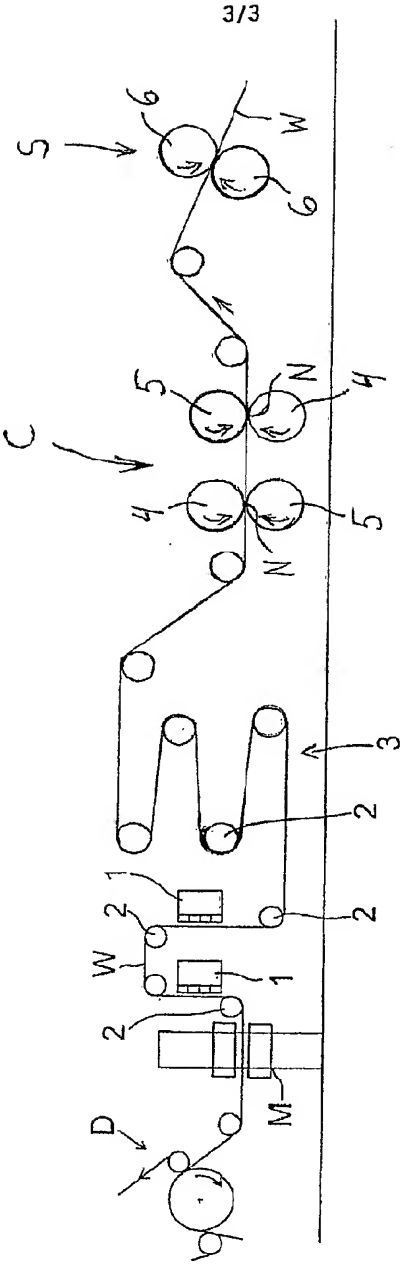


Fig. 5

INTERNATIONAL SEARCH REPORT

International Application No
PCT/FI2004/050155

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D21G1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D21G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 02/103109 A (METSO PAPER, INC; KORHONEN, HANNU; GROEN, JOHAN; TODOROVIC, ALEKSANDAR) 27 December 2002 (2002-12-27) cited in the application page 20, line 5 - page 22, line 15; figure 4	1-11
Y	US 2003/150581 A1 (LARES MATTI ET AL) 14 August 2003 (2003-08-14) paragraph '0020! - paragraph '0021!; claim 1; figure	1-11
Y	US 6 440 271 B1 (HEIKKINEN ANTTI ET AL) 27 August 2002 (2002-08-27) column 3, line 23 - column 5, line 60; figure 1	4,8

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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17 March 2005	29/03/2005

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/FI2004/050155

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PUB-NO: WO2005042837A1

DOCUMENT-IDENTIFIER: WO 2005042837 A1

TITLE: A PRECALENDERING METHOD AND A TREATMENT LINE FOR PAPER

PUBN-DATE: May 12, 2005

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APPL-NO: FI2004050155

APPL-DATE: November 1, 2004

PRIORITY-DATA: FI20031588A (November 3, 2003)

INT-CL (IPC): D21G001/00

EUR-CL (EPC): D21G001/00 , D21G001/00 , D21H023/30

ABSTRACT:

CHG DATE=20050524 STATUS=O>In a precalendering method the paper web is moistened and guided through a precalendering nip (N) that is formed between two surfaces. In the nip heat is conducted on the surface of the paper web (W) to be precalendered, and pressure is exerted thereon, whereafter the web is coated. The delay between the moistening and precalendering of the same side of the web (W) is 0.6 to 6.0 s. Thus, because of the long dwell time thereby attained it is possible to reduce the porosity and roughness of the surface of the base paper by means of precalendering before coating in a film transfer coater (S) taking place in the same line.